Final Memo

Date:	Tuesday, July 10, 2018;
Project:	City of Alexandria, Virginia, Resource Recovery Division Strategic Plan Review
To:	Michael Clem, Recycling Program Analyst
From:	Christopher Koehler, Susan Raila, and Kirk Dunbar, HDR
Subject:	Task 6 - Environmental Impacts and Economic Benefits of the Waste and Recycling Programs

Introduction

The City of Alexandria (City) is examining how it currently manages its solid waste and recyclable materials as part of its short-term and long-term strategic planning efforts. Identifying and evaluating the economic and environmental impacts and benefits associated with the City's existing solid waste and recycling programs is an integral part of the of the City's strategic planning efforts. One of the tasks associated with these planning efforts is to consider the environmental and economic impacts associated with the existing waste management system and estimate the environmental and economic impacts of potential changes to the waste management system.

HDR, in consultation with the City, developed a series of scenarios that, if implemented, will change the methodology of collection, management, and/or processing of the City's waste and recyclable streams. The objective of this exercise is to estimate if these changes will reduce greenhouse gas (GHG) emissions and estimate their economic impacts. GHG emissions reductions are typically used as a bellwether of environmental improvements and are used as a justification for change. This memo summarizes HDR's findings by comparing seven various scenarios that call for changes to the City's current solid waste management strategy. The seven scenarios are:

1. Eliminating the collection of glass from single stream recycling and instead, collecting glass for disposal at the A/A Facility.
2. Eliminating the collection of plastics #3-#7 from single stream recycling and instead, collecting plastics #3-#7 for combustion at the A/A Facility.
3. Eliminating the collection of glass and plastics #3-#7 from single stream recycling, and instead, collecting both glass and plastics #3-#7 for disposal and combustion at the A/A Facility.
4. Eliminating the collection of glass from single stream recycling but allowing residents to recycle glass at the four (4) Recycling Drop-Off Centers.
5. Converting all collection trucks from Diesel Fuel to Compressed Natural Gas (CNG).
6. Organics Management
   A. Diverting Yard Waste from composting and combusting Yard Waste at the A/A Facility.
   B. Diverting Leaf Waste from the City's mulching operation and combusting Leaf Waste at the A/A Facility.
7. Collecting Residential Food Waste and hauling Food Waste to be composted.

Background and Assumptions

Previously, HDR examined the Mid-Atlantic recycling markets and noted that there is currently instability in the recyclables commodities market due to China's National Sword Program. This instability is causing prices for processed recyclable materials to fall. The City has already begun to feel this impact.

For an extended period of time, the City was receiving payments from Waste Management Inc. (WMI) as part of the profit/cost sharing agreement associated with WMI's contract to process and sell the City recyclables. Recently, prices have declined to a level where the City will be making additional payments to share the processing costs, in other words, paying an additional monthly fee per ton versus receiving a monthly payment per ton. Because of the current uncertainty surrounding the recyclables market, HDR has assumed that, moving forward, there will be no payment or cost sharing.

For most evaluations included herein, HDR ignores collection costs for recyclables and waste. This is based on the understanding that collection costs will not change due to small variations in the tonnage collected each year. Collection fees are considered if the materials collected were not a part of the curbside recycling or waste collection program previously, such as food waste.

It is also assumed that the existing fleet of collection vehicles and existing labor force has the capacity to manage a modest increase in the amount of materials collected without having to add equipment or labor. The largest change modeled was 1,740 tons/year of glass and 39 tons of plastics (1,779 tons total) shifted from the recycling routes to the waste collection routes. This equates to approximately 34 tons per week; about 8.5 tons per collection day, or about 0.5 tons per collection truck per day (based on a fleet of 17 front and rear loading packer trucks).

In Scenario #6B, the assumption above does not apply, as the collection and processing of 8,245 tons per year (TPY) of leaves from the curbside Leaf Vacuuming Program utilizes its own fleet of vacuum trucks. This program is active for only 8-12 weeks in the fall and uses different trucks than the curbside waste collection trucks.

Waste Reduction Model (WARM)

The United States Environmental Protection Agency (EPA) created WARM to help solid waste planners and organizations track and voluntarily report GHG emissions reductions from six different waste management practices – source reduction, recycling, composting, anaerobic digestion, combustion and landfilling.

HDR has used the model to compare GHG emissions from the baseline solid waste management of existing practices to GHG emissions from an array of alternate waste management practices. GHGs were evaluated in metric tons of carbon dioxide equivalent (MTCO2E).

Using the Waste Reduction Model (WARM), HDR was able to estimate the environmental benefits of each of these seven scenarios in metric tons of carbon dioxide equivalents (MTCO2E). For the sake of comparison, one MTCO2E is equivalent to the emissions released by 0.24 mid-sized automobiles driven for a year.

It should be noted that this task was developed to evaluate the economics and environmental impacts via air emissions only. This task does not evaluate the implementation of any scenarios nor does it attempt to justify any scenario with regards to political, moral or cultural values.

Single Stream Recycling System

Current Conditions

The collection of single stream recyclables from households is provided under a seven-year contract with Bates Trucking and Trash Removal (Bates). Bates is paid $2.67 per household per month to collect single stream recyclables and deliver them to Waste Management Inc.'s (WMI's) Merrifield Transfer Station. Residents have the option of selecting one of three sizes of collection container: 18 gallon bin, 35 gallon wheeled cart, or 65 gallon wheeled cart. The recyclables are collected with a rear-loading packer truck. On most days, the contractor uses three trucks with a driver and two helpers on each. The contractor is also required to provide an on-site field supervisor and deliver recycling carts as needed. The City purchases and stores the recycling carts.

The consolidation of the single stream recyclables is performed by WMI at their Merrifield Transfer Station under a separate contract with the City. Recyclables are then transferred and hauled to a regional single-stream material recovery facility in Manassas, VA owned and operated by Republic Waste Services, Inc., where they are processed and sold. The City pays WMI a $72 per ton processing fee for recyclables and receives revenue or pays additional fees based on a contractual revenue sharing formula using market-pricing indexes.

Scenario #1 – Eliminating the Collection of Glass from Single Stream Recycling and Collecting Glass in with Curbside Waste

This scenario eliminates the collection of glass from the single stream recycling program and instead collects the glass along with the curbside waste and delivers it to the A/A Facility for combustion. The analysis was performed based on the City recovering approximately 1,740 tons of glass from the single stream recycling program in FY2016.

Baseline – The baseline condition for Scenario 1 below outlines the current management of glass, and is based upon the following information and assumptions:

- Materials management – WMI uses the glass recovered from the collected single stream as alternate daily cover (ADC) at the nearest landfill assumed to be Prince William County Landfill in Manassas, VA.
- The distance traveled by the glass from curb to disposal is about 47 miles, estimated as follows:
    - Distance from curbside pickup to the Merrifield Transfer Station (MTS) is about 11 miles,
    - Distance from MTS to Republic's single stream sorting facility in Manassas, VA is about 20 miles,
    - Distance from the Manassas facility to the Prince William Landfill is about 16 miles.

- WMI's contractual processing fee per ton from Task 1-2 Memo is $72 x 1,740 tons = $125,280.
- Based on the current revenue formula, glass does not provide any revenue to the City.

Alternate – The alternate materials management for Scenario 1 analyzes eliminating the collection of glass from single stream recyclables, and is based upon the following information and assumptions:

- Materials management – The glass will be collected with curbside trash and taken to the Alexandria/Arlington Waste to Energy (A/A) Facility.
- The existing waste collection fleet has the capacity to absorb 1,740 tons of additional materials without an increase in equipment or labor.
- The average distance from curbside pickup to the A/A Facility is 3 miles.
- Disposal at the A/A Facility is $43.16/ton x 1,740 Tons = $75,098.

Table 1 below provides a summary of the potential change in emissions per year from baseline.

Scenario	Description	Baseline Emissions MTCO2E/yr	Alternative Emissions MTCO2E/yr	Change MTCO2E/yr*
Scenario 1	Eliminating the Collection of Glass from Single Stream Recycling and Collecting Glass with Curbside Waste and Disposing at the A/A Facility	42.9	44.5	+1.6

*A negative number indicates lower emissions.

Table 2 below summarizes the potential economic savings per year from the baseline.

Scenario	Description	Baseline Costs	Alternative Costs	Cost Savings/yr
Scenario 1	Eliminating the Collection of Glass from Single Stream Recycling and Collecting Glass with Curbside Waste and Disposing at the A/A Facility	$125,280	$75,098	$50,182

Scenario #2 – Eliminating the Collection of Plastics #3-#7 from Single Stream Recycling and Collecting Plastics #3-#7 with Curbside Waste

Currently plastics #3-#7 are collected within the curbside single stream program. In 2016, the City collected 39 tons of these materials. In addition the contractual formula for calculating revenue sharing does not include plastics #3-#7. This scenario evaluates eliminating collection of Plastic #3-#7 from the single stream recycling program and instead collecting these materials with the curbside collection of waste to be delivered to the A/A Facility for combustion.

Although the WARM model accommodates the recycling of plastics #1 and #2, recycling of plastics #3-#7 is not specifically included in the model parameters. To run this scenario, the plastics #3-#7

were entered into WARM under the "Mixed Plastics" category. The analysis was performed based on the 39 tons of plastics #3-#7 recovered from the single stream recycling in 2016.

Baseline – The baseline conditions for Scenario 2 included the following information and assumptions:

- Materials management – WMI sends the recovered plastics #3-#7 recovered from the collected single stream to the Boomerang Recovery facility in Virginia Beach, VA.
- The distance traveled by the plastics #3-#7 from curb to recycling facility is about 232 miles, estimated as follows:
    - Distance from curbside pickup to the Merrifield Transfer Station (MTS) is about 11 miles,
    - Distance from MTS to Republic's single stream sorting facility in Manassas, VA is about 20 miles,
    - Distance from the Manassas facility to the Boomerang Recovery facility in Virginia Beach, VA is about 201 miles.
- WMI contractual processing fee is$72/ton x 39 tons of plastics = $2,808.
- Based on the current revenue formula, plastics #3-#7 do not provide any revenue to the City.

Alternate – The alternate materials management for Scenario 2 included the following information and assumptions:

- Materials management – The plastics #3-#7 will not be source separated and collected with other recyclable materials within the single stream program and will be collected with other waste materials in the curbside collection program and be taken to the A/A Facility.
- The existing waste collection fleet has the capacity to absorb 39 tons of additional materials without an increase in equipment or labor.
- The average distance from curbside pickup to the A/A Facility is 3 miles.
- Disposal at the A/A Facility is $43.16/ton x 39 tons of plastics = $1,683.

Table 3 below provides a summary of the potential change in emissions per year from baseline.

Scenario	Description	Baseline Emissions MTCO2E/yr	Alternative Emissions MTCO2E/yr	Change MTCO2E/yr*
Scenario 2	Eliminating the Collection of Plastics #3-#7 from Single Stream Recycling and Collecting Plastics #3-#7 with Curbside Waste for Combustion at the A/A Facility	-38.1	44.9	+83

*A negative number indicates lower emissions.

Table 4 below summarizes the potential economic savings per year from the baseline.

Scenario	Description	Baseline Costs	Alternative Costs	Cost Savings/yr
Scenario 2	Eliminating the Collection of Plastics #3-#7 from Single Stream Recycling and Collecting Plastics #3-#7 with Curbside Waste for Combustion at the A/A Facility	$2,808	$1,683	$1,125

Scenario #3 – Eliminating the Collection of Glass and Plastics #3-#7 from Single Stream Recycling and Collecting Glass and Plastics #3-#7 with Curbside Waste

This scenario combines Scenarios 1 and 2 and eliminates the collection of glass and plastics #3-#7 from the single stream program and instead collects these materials along with solid wastes and delivers them to the A/A Facility for combustion. The scenario assumes that the existing waste collection fleet has the capacity to absorb 1,740 tons of glass and 39 tons of #3-#7 plastics without an increase in equipment or labor.

The results of Scenarios 1 and 2 were combined to determine the impact of implementing both alternate materials management options.

Table 5 below provides a summary of the potential change in emissions per year from baseline.

Scenario	Description	Baseline Emissions MTCO2E/yr	Alternative Emissions MTCO2E/yr	Change MTCO2E/yr*
Scenario 3	Eliminating the Collection of Glass and Plastics #3-#7 from Single Stream Recycling and Collecting Glass and Plastics #3-#7 with Curbside Waste for Disposal and Combustion at the A/A Facility	14.8	89.4	+74.6

*A negative number indicates lower emissions.

Table 6 below summarizes the potential economic savings per year from the baseline.

Scenario	Description	Baseline Costs	Alternative Costs	Cost Savings/yr
Scenario 3	Eliminating the Collection of Glass and Plastics #3-#7 from Single Stream Recycling and Collecting Glass and Plastics #3-#7 with Curbside Waste for Disposal at the A/A Facility	$128,088	$76,781	$51,307

Scenario #4 – Eliminating the Collection of Glass from Single Stream Recycling but Allowing Residents to Recycle Glass at the Four Recycling Drop-Off Centers

This scenario eliminates the collection of glass within the single stream collection program but allows the glass to be voluntarily dropped-off at any of the recycling drop-off facilities. The analysis was performed based on the 1,740 tons of glass recovered from the single stream recycling in 2016 and on an estimate that 15% of that glass would be taken to a drop-off Center if not collected curbside. This percentage was discussed with City and deemed reasonable. The remainder of the glass will be collected with the curbside waste and taken to the A/A Facility.

Baseline – The baseline conditions for Scenario 4 included the following information and assumptions:

- Materials management – WMI uses the glass recovered from the collected single stream as alternate daily cover (ADC) at their nearest landfill, assumed to be the Prince William County Landfill in Manassas, VA.
- The distance traveled by the glass from curb to disposal is about 47 miles, estimated as follows:
    - Distance from curbside pickup to the Merrifield Transfer Station (MTW) is about 11 miles,
    - Distance from MTS to Republic's single stream sorting facility in Manassas, VA is about 20 miles,
    - Distance from the Manassas facility to the Prince William Landfill is about 16 miles.
- WMI contractual processing fee per ton is $72 x 1,740 tons of glass = $125,280.

Alternate – The alternate materials management for Scenario 4 included the following information and assumptions:

- Materials management:
    - Alternative A – The 261 tons of glass recovered from the drop off centers is sent to the I-95 Landfill Complex where it is ground and used to replace sand and aggregate. Based on WARM documentation, this portion of the glass was modeled as concrete being recycled to estimate the GHG impacts for the aggregate replacement.
    - Alternative B – The 261 tons of glass recovered from the drop off centers is sorted by color and sent to a Strategic Materials facility in Wilson, NC to be recycled.
    - For both alternatives, the remaining 1,478 tons of glass are taken to the A/A Facility.
- The one-way distance traveled by the glass from drop off center to disposal is:
    - Alternative A - Average distance from the drop off centers to the I-95 Landfill Complex is about 15 miles.
    - Distance from the drop off centers to the Strategic Industries facility in Wilson, NC is about 250 miles.
- WMI contractual processing fee from Task 1-2 Memo - $72/ton x 261 tons of glass = $18,792.

- City disposal at the A/A Facility cost from Task 1-2 Memo - $43.16/ton x 1,478 tons of glass = $63,833.
- Total cost = $18,792 + $63,833 = $82,625.

Table 7 below provides a summary of the potential change in emissions per year from baseline

Scenario	Description	Baseline Emissions MTCO2E/yr	Alternative Emissions MTCO2E/yr	Change MTCO2E/yr*
Scenario 4A	Eliminating the Collection of Glass from Single Stream Recycling, Allowing Residents to Recycle Glass at the Four Recycling Drop-Off Centers, Collected Glass Ground for Use as Aggregate, Remainder collected with Curbside Waste and Disposed of at the A/A Facility	42.9	35.5	-7.4
Scenario 4B	Eliminating the Collection of Glass from Single Stream Recycling, Allowing Residents to Recycle Glass at the Four Recycling Drop-Off Centers, Collected Glass Recycled, Remainder Collected with Curbside Waste and Disposed of at the A/A Facility	42.9	-24.5	-67.4

*A negative number indicates lower emissions.

Table 8 below summarizes the potential economic savings per year from the baseline.

Scenario	Description	Baseline Costs	Alternative Costs	Cost Savings/yr
Scenario 4A & Scenario 4B	Eliminating the Collection of Glass from Single Stream Recycling but Allowing Residents to Recycle Glass at the Four Recycling Drop-Off Centers	$125,208	$82,582	$42,626

Discussion Scenarios #1-#4

GLASS - It should be noted that many communities throughout the country are ending their glass collection programs. Glass is currently a liability from a recycling perspective. The current NY/mid-Atlantic market for mixed glass is negative (meaning you pay to get rid of it). That said, in many municipalities it is still cost-effective to pay only $5-15/ton to recycle glass, in lieu of paying $35 or more/ton to dispose of glass.

Economics aside, a major issue with glass is that it contaminates other recyclable materials. Glass breaks during collection and processing and the glass shards contaminate the other products, specifically cardboard and paper. The glass shards that are mixed with recovered paper go on to

damage paper mill equipment causing a higher rate of shutdown for repairs and replacement. One paper mill averaged 37 tons of glass contamination per month over a 6-month period in 2009(1). In addition, broken glass is a safety hazard to solid waste employees.

That said, glass has been a mainstay in recycling for decades. The public is accustomed to recycling glass irrespective of the economics. One Marion County, Florida resident summed it up by saying, "The advantages of recycling glass seem to outweigh its disadvantages. Less energy is consumed by reuse. Less waste. Less consumption of resources. Less landfill. Less litter. Less, less, less." The same article found that, "...more than 90 percent of stakeholders surveyed by the Glass Recycling Coalition said that the public expects to recycle glass.(2)"

Ending glass recycling, regardless of economics or emissions, may be a tough sell to the public. The City may wish to consider ending curbside collection of glass while expanding collection of glass at the drop-off centers.

PLASTICS - Although the economics currently do not currently favor the collection and recycling of Plastics #3-#7, their will be an overall increase in emissions (almost 75 MTCO2E/yr) if they are combusted at the A/A Facility. The City is likely to encounter the same resistance and public sentiment to discontinue plastics recycling as it will for discontinuing glass recycling. The estimated total annual tonnage of Plastics #3-#7 is only 39 tons. Continued collection and recycling of this material will not make a large impact on the cost of the City's overall waste program.

Conversion of Collection Trucks to CNG

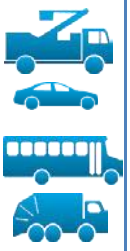
Current Conditions

The City owns and operates a fleet of 17 diesel rear loading and front loading packer trucks. The current fleet of trucks averages 9,300 miles per month.

The City's Environmental Action Plan 2030 (EAP) addresses the development of supplemental policies, plans and strategies over the next 20 years evolving towards a sustainability model that includes "creating a City fleet management plan to minimize the emissions of greenhouse gases from city vehicles."

Waste trucks typically have poor fuel efficiency due to the continual stopping and starting as waste is collected in residential neighborhoods. CNG trucks can save on fuel costs, however up-front costs are significant and include upgrades to trucks and installation of a specialized CNG fueling station, unless a nearby fueling station is available. The below table from the US Department of Energy study on converting waste collection trucks to CNG provides and estimated cost for installation of a CNG fueling station.

TABLE 9 - US DEPARTMENT OF ENERGY 2014 SMALL CNG STATION ESTIMATED COSTS (2014)[3]

Type	Cost Range	Example Applications	Assumptions
Fast-Fill 	$400,000–$600,000	**Private fleet station serving:** • 15–25 pickups/delivery vans fueling 7 gge/day or • 9–16 taxis/work trucks fueling 12 gge/day	• One 40–75 scfm (19–24 gge/hr) compressor • 5–15 psi inlet gas pressure • 16,250 scf storage (129 gge) • One single-hose metered dispenser • Included installation costs are estimated at 65% of equipment costs
Time-Fill 	$250,000–$500,000	**Private fleet station serving:** • 10–20 school buses fueling 10 gge/night, • 5–10 refuse vehicles fueling 20 gge/night, or • 15–20 sedans/pickups fueling 7 gge/night**	• One 20-50 scfm (10–24 gge/hr) compressor • 5–10 psi inlet gas pressure • 10 dual-hose posts • One time-fill panel; 10-hour fueling window • Included installation costs are estimated at 65% of equipment costs

* gge (gallon gasoline equivalent) = 126 scf (standard cubic feet).
**A time fill station can accommodate more vehicles than hoses if the vehicles do not fuel every day.

It was assumed that each of the 17 collection trucks would refuel every other day; approximately 9 each day. Costs reflect the upper end of the costs from the Department of Energy estimates. Note that costs for CNG stations can vary substantially based on vendors. In addition to the cost of the fueling station, purchasing CNG trucks are typically $30,000 to $50,000 more expensive per truck than purchasing diesel trucks. The 2014 US DOE Case Study – Compressed Natural Gas Fleet had the following major findings:

- Fleets in the study saved approximately $0.90 per mile in fuel costs by using CNG.
- Fleets in the study chose CNG to save money on fuel (around 50% on average), and to satisfy corporate or municipal environmental initiatives.
- The incremental cost of the CNG vehicles and fueling infrastructure can be recouped in 3-8 years.
- Driver feedback has been very positive: drivers appreciate the quieter operation of the trucks and noted the good acceleration performance.
- Both the diesel and CNG trucks in the case study traveled around 14,500 miles per year on average and each achieved fuel economy of 2.1 miles per diesel gallon equivalent.

Scenario #5 – Converting all Collection Trucks from Diesel Fuel to Compressed Natural Gas (CNG)

WARM cannot directly evaluate the GHG impacts of converting collection trucks from diesel to CNG fuel. Therefore, the analysis for this scenario was based on the mileage traveled by the City's trucks in 2016 (111,588 miles), the fuel economies from the USDOE case study cited above, and energy content, emission factors, and global warming potentials obtained from EPA's Mandatory Greenhouse Gas Reporting rules at 40 CFR Part 68.

Baseline – The baseline conditions for Scenario 5 included the following information and assumptions:

- City miles traveled in 2016 – 111,588 miles.
- City has current property available to construct the fueling station.
- Fueling Station Costs per US Department of Energy February 2014 Case Study – Compressed Natural Gas Refuse Fleet $500,000[(3)] cost amortized over 10 years at 4% interest = $60,744 per year.
- CNG Truck conversion – 17 City trucks to be converted at a cost of $40,000[(3)] per truck = $680,000. City converts all trucks over 4 year period = $170,000 per year.
- $0.90 per mile cost savings x 111,588 miles per year = $100,429 per year.[(3)]

Table 10 below provides a summary of the potential change in emissions per year from baseline.

Scenario	Description	Baseline Emissions MTCO2E/yr	Alternative Emissions MTCO2E/yr	Change MTCO2E/yr*
Scenario 5	Converting all Collection Trucks from Diesel Fuel to Compressed Natural Gas (CNG)	544.0	389.0	-155.0

*A negative number indicates lower emissions.

Table 11 below summarizes the potential economic savings per year from the baseline.

Scenario	Description	Baseline Costs	Cost Savings/yr
Scenario 5	Converting all Collection Trucks from Diesel Fuel to Compressed Natural Gas (CNG)		
	Facility Cost	$60,744	
	CNG Truck Conversion	$170,000	
	Total Costs	**$230,744**	
	Fuel Savings Per Year	($100,429)	
	Total Costs Per Year		($130,314)

Discussion Scenario #5

Scenario #5 evaluates potential emissions reductions by converting the collection fleet to CNG. CNG was used because it is a proven technology that has a history of success in waste collection programs.

After the initial cost for conversion to CNG over the 4 year period has been accomplished, the City will realize a cost savings of $40,000 per year due to the fuel savings. Once the fueling station costs have been fully amortized, the costs savings per year would be $100,000.

The City inquired about the use and modeling of electric waste collection vehicles. While it is tempting to model electric waste collection vehicles, the use of electric trucks for waste collection is currently limited. Los Angeles, CA conducted a pilot program using one (1) electric truck that had a range of 100-miles and a capacity of 4 tons. Sacramento, CA added one (1) electric collection truck

to its fleet in 2017. The City of Chicago has reportedly ordered 20 electric waste collection trucks stipulating that each truck must have a range of 60-miles with a capacity of 9 tons[4]. It is too early to make any statements about the performance of these electric collection vehicles and cost information was not readily available. Despite the lack of data, it is safe to say that electric collection trucks will have the biggest impact in congested areas where air and noise pollution are most evident.

Our current opinion is to take a 'wait and see" approach on electric collection vehicles.

Leaf and Yard Waste

Leaf and Yard Waste Programs

The City has two (2) programs for the collection of leaf and yard wastes; 1) Curbside Collection of Yard Waste Program; and 2) Leaf Vacuuming Program.

Yard Waste Collection Program

The Yard Waste Collection Program provides weekly, year round collection of yard waste from residential properties using rear-loading packer trucks operating on the same day as trash collection. In FY2016 the Yard Waste Collection Program used two (2) rear loading trucks each with an operator and one (1) laborer and collected and hauled approximately 535 tons of yard waste to the Western Branch Composting Facility located in Prince Georges County, MD (approximately 23 miles away). Total collection, hauling, and processing costs for this program are estimated to be $632/ton. This cost is based on an estimated cost of $338,345 divided by 535 tons = $632/ton.

Leaf Vacuuming Program

The Leaf Vacuuming Program requires residents to rake leaves to the curb where five (5) City operated vacuum trucks collect the materials over 8-12 weeks from October through December each year. In 2016, the City collected 8,245 tons of residential yard waste using vacuum trucks. The vacuum trucks deliver all materials to the City's mulching facility on Eisenhower Avenue. The Leaf Vacuuming Program is estimated to cost $778,962/year. This cost was divided by 8,245 tons = $112/ton.

The finished mulch is used by the City for municipal landscaping purposes and is provided to City residents for free during the spring and early summer months. There is also a mulch delivery service for City residents at a cost of $50 for a six cubic yard load.

Scenario #6A – Diverting Yard Waste from Composting and Disposing of Yard Waste with Curbside Waste

This scenario essentially evaluates if it is better to haul yard waste 23 miles to compost it at the Western Branch Composting Facility or haul only three miles to the A/A Facility for combustion. Composting is simply the breaking down of organic materials under natural conditions and this natural process still gives off carbon emissions. However, the hauling of yard waste does contribute additional carbon emissions due to truck exhaust.

The analysis was performed based on the 535 tons of yard waste collected curbside and hauled to the Western Branch Composting Facility for composting in 2016.

Baseline – The baseline conditions for Scenario 6A included the following information and assumptions:

- Materials management – the yard waste is composted.
- The distance traveled by the yard waste from curbside to the Western Branch facility is about 23 miles.
- Western Branch Composting cost from Task 1-2 Memo was approximately $612/ton or $338,345 per year.

Alternate – The alternate materials management for Scenario 6A included the following information and assumptions:

- Materials management – the yard waste will be collected curbside mixed with waste and taken to the A/A Facility.
- The existing waste collection fleet has the capacity to absorb 535 tons/year of additional materials without an increase in equipment or labor.
- The average distance from curbside pickup to the A/A Facility is 3 miles.
- City collection and disposal to the A/A Facility cost per ton from Task 1-2 Memo - $150 x 535 tons of yard waste = $80,250.

Table 12 below provides a summary of the potential change in emissions per year from baseline.

Scenario	Description	Baseline Emissions MTCO2E/yr	Alternative Emissions MTCO2E/yr	Change MTCO2E/yr*
Scenario 6A	Diverting Yard Waste from Composting and Combusting Yard Waste at the A/A Facility	-78.0	-100.5	-22.5

*A negative number indicates lower emissions.

Table 13 below summarizes the potential economic savings per year from baseline.

Scenario	Description	Baseline Costs	Alternative Costs	Cost Savings/yr
Scenario 6A	Diverting Yard Waste from Composting and Combusting Yard Waste at the A/A Facility	$338,345	$80,250	$258,095

Scenario #6B – Diversion of Leaf Waste from the City Mulching Operation and Disposing of Leaf Waste with Curbside Waste

This scenario is similar to Scenario #6A but evaluates the difference between bringing leaves collected by the City's Leaf Vacuuming Program to the existing City mulching operation (abuts the

A/A Facility) or bringing the leaf waste to the A/A Facility for combustion. Essentially this compares mulching to combustion as the hauling distance is the same.

Although WARM accommodates the composting of leaves and other yard waste, "mulching" of materials is not an option. To run this scenario, the leaf waste was input to WARM using the "Leaves" category, with "Composting" chosen as the baseline material management. In the composting management options, WARM includes GHG emissions generated by equipment used to periodically turn the compost windrows. For the purposes of this study, the GHG contribution of this turning equipment was assumed to adequately reflect the GHG emissions generated by the tub grinder used by the City at the City Leaf Storage Facility. The analysis was performed based on the 8,245 tons of leaf waste collected by the City's leaf vacuuming program and sent to the City's mulching operation in 2016.

Baseline – The baseline conditions for Scenario 6B included the following information and assumptions:

- Materials management – the leaf waste consists mostly of leaves and is ground into mulch using the City's tub grinder.
- The average distance traveled by the leaf vacuum trucks from curbside to the City facility is 3 miles.
- City Leaf Vacuuming Program Collection Cost from Task 1-2 Memo - $692,806.
- City Leaf Vacuuming Program Grinding/Processing Cost from Task 1-2 Memo - $230,935.
- Total Cost of Baseline = $923,741 or $112 per ton.

Alternate – The alternate materials management for Scenario 6B included the following information and assumptions:

- Materials management – the leaf waste will be collected with curbside Leaf Vacuuming Program and taken to the A/A Facility.
- The average distance from curbside pickup to the A/A Facility is 3 miles.
- City Leaf Vacuuming Program Collection Cost from Task 1-2 Memo - $692,806.
- City disposal cost at the A/A Facility will be $43.16/ton in disposal fees x 8,245 tons = $355,854.
- Total cost of Alternate = $1,048,660 or $127 per ton.

Table 14 below provides a summary of potential change in emissions per year from baseline

Scenario	Description	Baseline Emissions MTCO2E/yr	Alternative Emissions MTCO2E/yr	Change MTCO2E/yr*
Scenario 6B	Diverting Leaf Waste from Mulching and Combusting Leaf Waste at The A/A Facility	-1,228.0	-1,548.3	-320.3

*A negative number indicates lower emissions.

Table 15 below summarizes the potential economic savings per year from the baseline.

Scenario	Description	Baseline Costs	Alternative Costs	Cost Savings/yr
Scenario 6B	Diverting Leaf Waste from Mulching and Combusting Leaf Waste at The A/A Facility	$923,741	$1,048,660	($124,919)

Discussion Scenarios #6A and #6B

The scenarios above only take into account GHG emissions and costs, it should be noted that composting and mulching do have environmental benefits that are not reflected in the models.

Composting and mulching can help reduce the amount of waste that would otherwise go to a landfill or other disposal facility. Utilizing the compost as a soil additive helps improve the quality of soil and reduces the need for chemical fertilizers. Mulch is spread on slopes and other areas to help reduce erosion and also help retain moisture, cutting down and the need for irrigation.

The City should be mindful that even though it is difficult to put a dollar value on these benefits, they have positive impacts to the City.

In addition, the City does not currently require yard waste be separated and set out for curbside collection. The City has estimated that approximately 80% of yard waste remains mixed with the curbside trash collection program and is disposed of at the A/A facility with the rest of the trash. The City may consider changing the by-laws and imposing a ban of these materials from curbside trash. That, along with a robust education campaign will promote the composting of these materials and help reduce costs on a per ton basis.

Also note that the economics of Scenario 6B will change in 2025 when the tipping fee at the A/A Facility goes to $0.00/ton. At that point the costs to collect and deliver leaf waste to the mulching operation will be equal to the cost to collect and dispose of leaf waste at the A/A Facility. However, the City cannot increase their tonnage disposed of at the A/A Facility by 8,245 tons over the course of one year due to terms in the contract, but they may be able to over the course of several years. When the time comes, the City may wish to reconsider delivering the leaf waste to the A/A facility. Until then it is less costly to process the leaves at the mulching facility.

Food Waste

In 2014, the EPA estimated that 14.9% of the MSW waste stream disposed is food waste[5]. Based on the EPA estimate, there is a potential to recycle approximately 3,160 tons of food waste from the City's residential waste stream.

The City does not currently have a curbside organics program but residents have an option to divert food waste at four farmers markets: Old Town Farmer's Market; Del Ray Farmer's Market; Four Mile Run Farmer's Market; and West End Farmer's Market. Food wastes are accepted year-round when the markets are open. The farmer's market food collection stations have been in place for four years and cost approximately $36,000/year, which includes staffing, supplies, hauling and processing. In general, quantities collected have doubled every year as residents have become more aware of the program. In 2014, 2015, and 2016 the stations collected 39, 65, and 125 tons, respectively.

Food waste is collected at these locations and transferred to a central holding facility by City staff. Bates picks up food waste once a week from the central holding facility and hauls it to the Western Branch facility in Prince Georges County, MD. Hauling costs ($27.68/ton) and processing costs ($45/ton) account for approximately $9,080 (FY16) of the program's total cost of $36,000. Overall costs to operate this program, including staff, supplies, hauling and processing are approximately $288/ton ($36,000 divided by 125 tons = $288/ton).

Scenario #7 – Collecting Residential Food Waste and Hauling Food Waste to be Composted

A residential food waste collection study conducted by the City concluded that 17% of the residents will put out eight (8) pounds of food waste per week. Based on the 20,200 households currently collected by the City, this extrapolates to 714 tons of food waste per year. The analysis was performed based upon this quantity of food waste being sent to the Western Branch Composting Facility.

Baseline – The baseline conditions for Scenario 7 included the following information and assumptions:

- Materials management – the 714 tons of food waste is collected with the curbside waste and combusted at the A/A Facility.
- The average distance from curbside pickup to the A/A Facility is 3 miles.
- City curbside collection and disposal to the A/A Facility cost per ton from Task 1-2 Memo - $150.
- Total cost of 714 tons X $150/ton = $107,100.

Alternate – The alternate materials management for Scenario 7 included the following information and assumptions:

- Materials management – the 714 tons of food waste will be taken to the Western Branch Composting Facility.
- The distance traveled by the food waste from curbside to the Western Branch facility is 23 miles.
- Hauling to the Western Branch Composting costs $27.68/ton.
- Tipping fee at the Western Branch Composting facility is $45/ton.
- Total management cost for food waste = $288/ton.
- Total Cost of $288/ton X 714 tons = $205,632

Table 16 below provides a summary of the potential change in emissions per year from the baseline.

Scenario	Description	Baseline Emissions MTCO2E/yr	Alternative Emissions MTCO2E/yr	Change MTCO2E/yr*
Scenario 7	Collecting Residential Food Waste and Hauling Food Waste to be Composted	-108.8	-125.3	-16.5

*A negative number indicates lower emissions.

Table 17 below summarizes the potential economic savings per year from the baseline.

Scenario	Description	Baseline Emissions MTCO2E/yr	Alternative Emissions MTCO2E/yr	Change MTCO2E/yr
Scenario 7	Collecting Residential Food Waste and Hauling Food Waste to be Composted	$107,000	$205,632	($98,632)

Summary of Environmental and Economic Impacts

The results of all the scenarios potential environmental and economic impacts described above are summarized in the following tables.

Table 18 - Summary of the Potential Change in Emissions per Year from Baseline

Scenario	Description	Baseline Emissions MTCO2E/yr	Alternative Emissions MTCO2E/yr	Change MTCO2E/yr*
Scenario 1	Eliminating the Collection of Glass from Single Stream Recycling and Collecting and Disposing of Glass at The A/A Facility	42.9	44.5	+1.6
Scenario 2	Eliminating the Collection of Plastics #3-#7 from Single Stream Recycling and Combusting Plastics #3-#7 at The A/A Facility	-38.1	44.9	+83
Scenario 3	Eliminating the Collection of Glass and Plastics #3-#7 from Single Stream Recycling and Disposing of Glass and combusting Plastics #3-#7 at The A/A Facility	14.8	89.4	+74.6
Scenario 4A	Eliminating the Collection of Glass from Single Stream Recycling, Allowing Residents to Recycle Glass at	42.9	35.5	-7.4

Scenario	Description	Baseline Emissions MTCO2E/yr	Alternative Emissions MTCO2E/yr	Change MTCO2E/yr*
	the Four Recycling Drop-Off Centers, Collected Glass Ground for Use as Aggregate, Remainder collected curbside with Trash and disposed of at The A/A Facility			
Scenario 4B	Eliminating the Collection of Glass from Single Stream Recycling, Allowing Residents to Recycle Glass at the Four Recycling Drop-Off Centers, Collected Glass Recycled, Remainder Collected Curbside with Trash and disposed at The A/A Facility	42.9	-24.5	-67.4
Scenario 5	Converting all Collection Trucks from Diesel Fuel to Compressed Natural Gas (CNG)	544.0	389.0	-155.0
Scenario 6A	Diverting Yard Waste from Composting and Combusting Yard Waste at The A/A Facility	-78.0	-100.5	-22.5
Scenario 6B	Diverting Leaf Waste from Mulching and Combusting Leaf Waste at The A/A Facility	-1,228.0	-1,548.3	-320.3
Scenario 7	Collecting Residential Food Waste and Hauling Food Waste to be Composted	-108.8	-125.3	-16.5

*A negative number indicates lower emissions.

Table 19 - Summary of the Potential Economic Change per Year from Baseline

Scenario	Description	Baseline Costs	Alternative Costs	Cost Savings/yr
Scenario 1	Eliminating the Collection of Glass from Single Stream Recycling and Collecting and Disposing of Glass at The A/A Facility	$125,280	$75,098	$50,182
Scenario 2	Eliminating the Collection of Plastics #3-#7 from Single Stream Recycling and Combusting Plastics #3-#7 at The A/A Facility	$2,808	$1,683	$1,125
Scenario 3	Eliminating the Collection of Glass and Plastics #3-#7 from Single Stream Recycling and Disposing of Glass and combusting Plastics #3-#7 at the A/A Facility	$128,088	$76,781	$51,307
Scenario 4A &/or	Eliminating the Collection of Glass from Single Stream Recycling, Allowing Residents to	$125,208	$82,582	$42,626

Scenario	Description	Baseline Costs	Alternative Costs	Cost Savings/yr
Scenario 4B	Recycle Glass at the Four Recycling Drop-Off Centers, Collected Glass Ground for Use as Aggregate, Remainder of Glass Collected Curbside with Trash and disposed of at the A/A Facility			
Scenario 5	Converting all Collection Trucks from Diesel Fuel to Compressed Natural Gas (CNG)			
	Facility Cost	$60,744		
	CNG Truck Conversion	$170,000		
	Total Costs	**$230,744**		
	Fuel Savings Per Year	($100,429)		
	Total Costs Per Year			**($130,314)**
Scenario 6A	Diverting Yard Waste from Composting and Disposing of Yard Waste with Curbside Waste	$338,345	$80,250	$258,095
Scenario 6B	Diverting Leaf Waste from Mulching and Disposing of Leaf Waste with Curbside Waste	$923,741	$1,048,660	($124,919)
Scenario 7	Collecting Residential Food Waste and Hauling Food Waste to be Composted	$107,000	$205,632	($98,632)

Recommendations

The City has some tough choices to make regarding their recycling and organics programs. The following are offered as recommendations for the City's consideration:

- While there is a long standing fundamental recycling paradigm that involves the recycling of glass, neither the WARM model nor the economics currently support the recycling of glass. There is no market for glass at the present time (except if separated by color), and glass does compromise the quality and price of other recyclable materials in the single stream system. The City should give serious consideration to eliminated glass from the single stream suite of materials collected curbside and provide outlets for the recycling of those materials at the four recycling drop-off centers.

- HDR recommends the City engage WMI in discussions regarding possible contractual changes from eliminating glass from the single stream program.

- Should the City decide to eliminate glass from the single stream recycling program, and allow residents to recycle glass at the drop-off facilities glass should be separated by color. This will allow for residents who still wish to recycle glass to do so and increase the marketability of the processed product, assuming there is a market at all.

- The WARM model supports the recycling of Plastics #3-#7, collected in the single stream recycling program. However, the economics do not. Nonetheless, due to the relatively small tonnage (39 tons per year), the City may want to continue collecting these materials.

- The City should decide if they wish to continue recycling glass and plastics #3-7 recycling prior to issuing a new RFP for processing and, if possible, prior to issuing an RFP for curbside collection of recyclables.

- Now that the City has extended the Bates hauling contract to coincide with the waste Management Inc. processing contract, the City may be able to combine these contracts and structure an invitation to bid (ITB) that will allow for awarding contracts based on collection costs, processing costs, or a combination of both. A legal opinion of this should be sought before embarking on this path.

- The City should consider converting the entire collection vehicle fleet to CNG. After the initial cost for conversion the existing fleet to CNG over a 4-year period, the City will realize a cost savings of $40,000/year due to the fuel savings. Once the fueling station costs have been fully amortized, the costs savings per year will be $100,000/year.

- Although the current method of the Leaf Vacuuming Program makes sense economically, the WARM model slightly favors A/A facility. The City should evaluate whether to continue the program in its current form prior to 2025 when the tipping fee at the A/A Facility goes to $0.00/ton.

- The City should consider:

    - Eliminating the Curbside Collection of Yard Waste Program and directing the relatively small amount of yard waste currently collected with trash to the A/A Facility; or
    - Amending current City By-laws to ban yard waste from being disposed with the curbside collection of trash and expand the Yard Waste Program which must include additional education and enforcement programs to help increase diversion of these materials.

- The City should explore developing its own composting operation either on the Eisenhower Avenue facility or another location within the City. A new composting facility may also reduce the cost of a potential future food waste collection and processing program.

Due to high costs for operation of the City's food waste collection program, the City should not consider curbside collection of food waste at this time. However, the City should continue to monitor neighboring community efforts for potential synergies and collaborations and revisit and reevaluate curbside collection of food waste occasionally as management methods develop.

Endnotes

(1) "Beyond the Curb, Tracking the Comingled Residential Recyclables from Southwest WA," Department of Ecology State of Washington, June 2010 (Publication No. 10-07-009).

(2) "No more glass recycling for Marion County"; Jim Ross, Feb 5, 2018; Ocala Star Banner; Ocala.com http://www.ocala.com/news/20180205/no-more-glass-recycling-for-marion-county

(3) US Department of Energy - February 2014; Case Study – Compressed Natural Gas Refuse Fleet. https://www.afdc.energy.gov/uploads/publication/casestudy_cng_refuse_feb2014.pdf

(4) "The future of collection trucks — it's electric! - It's only a matter of time before electric refuse trucks become more mainstream."; John Carlton; July 2017; Waste Today Magazine http://magazine.wastetodaymagazine.com/article/july-2017/the-future-of-collection-trucks--its-electric.aspx

(5) USEPA Website https://www.epa.gov/sites/production/files/2016-11/documents/2014_smm_tablesfigures_508.pdf see page 5